Anisotropic x-ray magnetic linear dichroism at the Fe $L_{2,3}$ edges in Fe_3O_4 thin films and other systems

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The detailed knowledge of the spin arrangements in engineered magnetic nanostructures comprised of multiple layers with very different magnetic characteristics is essential to tailor their properties for device applications in information storage technology. Soft x-ray magnetic dichroism spectroscopies play an ever increasing role in improving our understanding of complex heteromagnetic nanostructures since these techniques provide elemental and chemical site-specific magnetic information with high sensitivity and tunable probing depth. So has the interface coupling of a ferromagnetic layer grown on an antiferromagnet been studied for interfaces like Co/$LaFeO_3$ [1] and Co/NiO [2] using a creative combination of x ray magnetic linear and circular dichroism spectroscopy and microscopy. Moreover, the impact of the magnetization reversal in a ferromagnetic Co layer on the underlaying NiO in Co/NiO systems [3] and the influence of the Fe overlayer thickness on the exchange coupling of Fe and NiO in Fe/NiO systems has been analyzed [4].

It is obvious that using spectroscopic information for magnetometry and magnetic microscopy requires the detailed theoretical understanding of spectral shape and magnitude of dichroism signals.

In this contribution, we present the first observation as well as detailed theoretical description of anisotropic x ray magnetic linear dichroism (XMLD) at the Fe $L_{2,3}$ in Fe_3O_4 and other systems. We show unambiguously that - contrary to current belief - spectral shape and magnitude of the XMLD is not only determined by the relative orientation of magnetic moments and x ray polarization but that their orientation relative to the crystallographic axes has to be taken into account for the accurate interpretation of the XMLD data. This observation calls into question prior results based on XMLD data since this anisotropy has never before been considered in the interpretation of XMLD spectra. We will revisit some of the previous experimental results and reinterpret the experimental data based on our findings.

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